BE IT KNOWN that We, Vasco VOLLMER and Markus RADIMIRSCH, citizens of Germany, whose post office addresses are, respectively, Hahnenberger Strasse 16, 29471 Gartow, Germany; and Wirringer Garten 2, 30880 Laatzen, Germany, have invented certain new and useful improvements in a

METHOD OF REPEAT TRANSMISSION OF MESSAGES IN A CENTRALLY CONTROLLED COMMUNICATION NETWORK

of which the following is a complete specification thereof:

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of repeat transmission of messages in a centrally controlled communication network.

2. Prior Art

In a centrally controlled, especially cellular, radio network, a central station ZE is provided, as shown in Fig. 1, to which several terminals T1, T2,... can be connected. These terminals can be, for example, telephones, but also could be PCs (personal computers) or other units. This type of system operates, for example, in a link-oriented mode, i.e. prior to exchange of data with other terminals that are connected to the network or the central station ZE, at least one link or connection must be established.

Besides this connection or link in which only one terminal is operated, there are also connections or links, in which several or all terminals are simultaneously operated (Multicast, Broadcast). Complete error correction does not occur in the existing systems. However high error probabilities must be taken into account, especially in radio transmissions. Various methods have been developed to permit error sensitive transmission of data. In most cases a combination of error protective coding (Forward Error Correction, FEC) and automatic repeat requests (ARQ) are used. FEC is based on redundancies added in transmission, so that the message still can be corrected and received in the receiver without error, when it contains a few transmission errors. ARQ in

contrast is based on the assumption that the receiver can establish when a message was transmitted containing errors. This is generally achieved by using an additional check sum. When the receiver detects an error, it asks the transmitter to send this data packet to it again. For this latter method a bidirectional transmission is necessarily required. ARQ has already been investigated in detail and used in many variations for different applications (high and low error probabilities optimized, as described in A.S. Tanenbaum, "Computernetzwerke [Computer network]", Prentice Hall, München, 1998, pp. 227 to 244; B. Walke, "Mobilfunknetze und ihre Protokolle [Mobil Radio Network and its Protocols]", B. G. Teubner, Stuttgart, 1998, pp. 91 to 99; D. Petras. "Entwicklung und Leistungsbewertung einer ATM-Funkschnittstelle [Development and Performance Evaluation of an ATM Radio Interface]", Dissertation in RWTH Aachen, 1998, Chapter 8.3, pp. 81 to 85; and D. Bertsekas, R. Gallager, "Data Networks", Prentice-Hall, Englewood Cliffs, New Jersey, 1992, pp. 64 to 68. All these methods however are based on a bidirectional connection or link, i.e. generally a point-to-point link.

Summary of the Invention

It is an object of the present invention to provide an improved method for repeat transmission of messages in a centrally controlled communication network.

According to the invention the method for repeat transmission of messages in a centrally controlled communication network, especially a radio network, in which several terminals are simultaneously operable in a participating group, comprises the following steps:

a) transmitting of each of the messages from the central station only once for reception by the several terminals of the participating group and assigning a respective identifier to the corresponding messages to detect whether or not a transmitted message was incorrect or lost;

b) as soon as a terminal has established an error in or loss of a transmitted message, it issues a repeat request for a repeat transmission of this message over another communication link, especially a point-to-point link, between the central station and the terminal establishing the error or the loss; and

c) the central station repeats transmission of the erroneous or lost message in response to the repeat request within a predetermined time interval.

Features of preferred embodiments of the method are set forth in appended dependent claims.

During broadcast and multi-cast links, i.e. operating modes, in which terminals are simultaneously operated by the central station, it is possible to transmit repeat requests for repetition of message transmissions with the method according to the invention. Also a message, which should be received by the several terminals of a participating group, is only transmitted once for reception by all participating terminals but the single transmission is received and

processed by all participating terminals. The multi-cast operation (groups of several selected terminals of a radio cell) or also broadcast operation (all terminals found in the cell) happens in the current communication systems only in one direction, namely from the central station to the terminals (down-link). The method according to the invention uses another communication link, preferably an existing point-to-point link, between a terminal of the multi-cast group and/or broadcast participants and the central station in order to be able to perform a simple protocol for repeat requests, when a repetition of an error-containing or lost message is required within a predetermined time interval. Because of that the probability for transmission of an error-containing data packet is clearly reduced, without expensive error protecting measures being required. Since a point-to-point transmission for exchange of control information between the terminals and the central station, especially in HIPERLAN Type 2 communication systems, is provided anyway, no additional expenses for transmission of repeat requests are produced by the method according to the invention.

Repeat requests are of great importance, especially in radio networks, since error-free transmission of data with conventional methods (FEC) cannot be guaranteed because of physically limiting high error rates. In current conventional applications, such as speech transmission or image transmission, see GSM, DVB-T, this is not important, since they tolerate errors to a certain extent. In speech transmission a transmission error generally is noticeable only as a brief interfering noise. However when electronic data, such a software

programs or documents, must be transmitted over a radio network, scarcely any errors are tolerated, since they would in most cases make the entire data unreadable.

Brief Description of the Drawing

The objects, features and advantages of the invention will now be illustrated in more detail with the aid of the following description of the preferred embodiments, with reference to the accompanying figures in which:

Fig. 1 is a diagram of a centrally controlled communications network in which the method according to the invention can be used;

Fig. 2 is a diagram showing the course of a repeat request of an error-containing message; and

Fig. 3 is a diagram illustrating control of the time interval.

Description of the Preferred Embodiments

The method according to the invention for repeat transmission of messages is performed by the centrally controlled communication network, especially a HIPERLAN Type 2 communication system, illustrated in Fig. 1. The method according to the invention can of course also be applied to processes with other signaling.

In HIPERLAN Type 2 communication systems a terminal T1,T2,.. is assigned a temporary address, as long as it is connected with the central

station, i.e. is announced as a network participant. The temporary address (MAC-ID) is used during communication in order to address a terminal definitely within a cell. One or more predetermined addresses is or are provided for broadcast and multi-cast transmissions. The central station ZE transmits broadcast and multi-cast messages with the predetermined address or addresses as target or targets. All terminals in a cell, or all which belong to a multi-cast group, receive these messages. As in point-to-point links the messages contain an identifying feature, e.g. a running number (sequence number SN), with the aid of which a terminal can detect, whether a message is lost in the transmission or decoding. As soon as a terminal establishes the loss of a message or an erroneous message with the previously described mechanisms, it sends a repeat request, for example a negative acknowledgment (negative acknowledge NACK), which contains the sequence number of the lost message. This repeat request NACK is transmitted on one of the existing point-to-point links between a respective terminal and the central station ZE. At least one of these links is always present in order to exchange control information. The central station ZE repeats the message with the old sequence number SN. Because of that a terminal can receive the same message several times. Thus it is advantageous that another terminal which is part of the broadcast zone or a multi-cast group and which has already received the message with the correct sequence number erases it. Up to now only erroneous or lost message packets are acknowledged, i.e. in a repeat request whose sequence number is put in place as a negative acknowledgment NACK. Alternatively the correctly received

message packet can also be acknowledged – as a positive acknowledgment ACK. Instead of confirming a positive or negative acknowledgment, ACK or NACK, with only one sequence number, several can be entered, or all since the last acknowledgment can be positively or negatively acknowledged.

In order to prevent a terminal with very poor channel properties from clogging the entire transmission because of the need for frequent repeat transmissions a predetermined time window or interval is used, especially a so-called ARQ (automatic repeat request) window is used. This ARQ window is controlled so that a message can be repeated only within a predetermined time interval. The temporal granularity for this time window is the length of a message. A counter is provided for control of this time window, which increments with the sequence number SN. A modulo n counter is used particularly for that purpose, i.e. it jumps back to 0 after reaching a maximum value (N -1) and begins to increment again. N gives the number of successive messages. The window size then is given by the length of a message multiplied by the value N - 1. A repetition is accordingly only possible within SN+(N-1) transmitted messages. Thus the number of possible sequence numbers should be at least twice the number of the size of the ARQ window, in order to obtain a definite correlation. It is advantageous to limit the number of the maximum possible repeat requests of a certain message by a single terminal in order to prevent a delay of the transmission process by a rapid series of repeat requests from one terminal.

Only the preceding seven messages are stored in the central station ZE and also accordingly a repeat of only these seven messages is possible, based on a modulo-8 window in the embodiment shown in figures 2 and 3. Fig. 2 is a message flow diagram. A central station ZE and two terminals 1 and 2 are shown in Fig. 2. The vertical lines extending from the blocks represent respective time axes so that time increases in a downward direction. The central station ZE transmits a message that includes a sequence number SN. Reception of the message is indicated by an arrow reaching the time axis of the terminal receiving it. The erroneous transmission of the message is indicated by an X. As soon as a terminal receives a message with a sequence number larger than expected, it sends out a repeat request, i.e. a negative acknowledgment NACK with the expected sequence number SN. In Fig. 2 message 1 from terminal 1 would not be received or would be received with an error. This error is detected by the receiver of message 2 by the omitted sequence number and the repeat request NACK is sent back. After the input of the repeat request NACK to the central station ZE it transmits the corresponding message N (SN=1) again (after N(SN=3)). Terminal 1 receives now this message and resets its ARQ window. Terminal 2 has received this message already error free for the first time and rejects the repeat transmission which is indicated by the absent arrow tip or arrow head. Message 2 (SN=2) was received erroneously in contrast by terminal 2 and accordingly requests again and also transmits.

A memory is used for repetition of the messages within the ARQ window. The memory is controlled so that a message transmitted again writes over the

oldest version of the message still in the memory. Fig. 3 shows the principal process for doing that. A modulo 8 buffer is provided, in which each segment of the circle illustrated in Fig. 3 indicates a buffer location. A fresh message overwrites a respective message which is older by about eight intervals, i.e. having about eight steps lower sequence number.

The disclosure in German Patent Application 199 27 639.0 of June 17, 1999 is incorporated here by reference. This German Patent Application describes the invention described hereinabove and claimed in the claims appended hereinbelow and provides the basis for a claim of priority for the instant invention under 35 U.S.C. 119.

While the invention has been illustrated and described as embodied in a method for repeat transmission of messages in a centrally controlled communication network, it is not intended to be limited to the details shown, since various modifications and changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed is new and is set forth in the following appended claims.